



Armed Forces College of Medicine AFCM



Male Genital System (Semineferous tubules)

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1- Describe the microscopic structure of the testis (seminiferous tubules, Sertoli cells) by LM & EM

2- Correlate the microscopic structure of the different cells of the seminiferous tubules to their function.

3- Discuss the steps of spermatogenesis and spermiogenesis

4- Interpret the histological changes in the testis

Lecture Plan



1. Part 1 (5 min)
2. Part 2 (35 min)
3. Part 3 (5 min)
4. Lecture Quiz (5 min)

Male reproductive system



1- **Testis** (sperms & testosterone)

2- **Duct System**

1- Straight tubules

2- Rete testis

3- Efferent ductules

4- Epididymis

5- Vas deferens

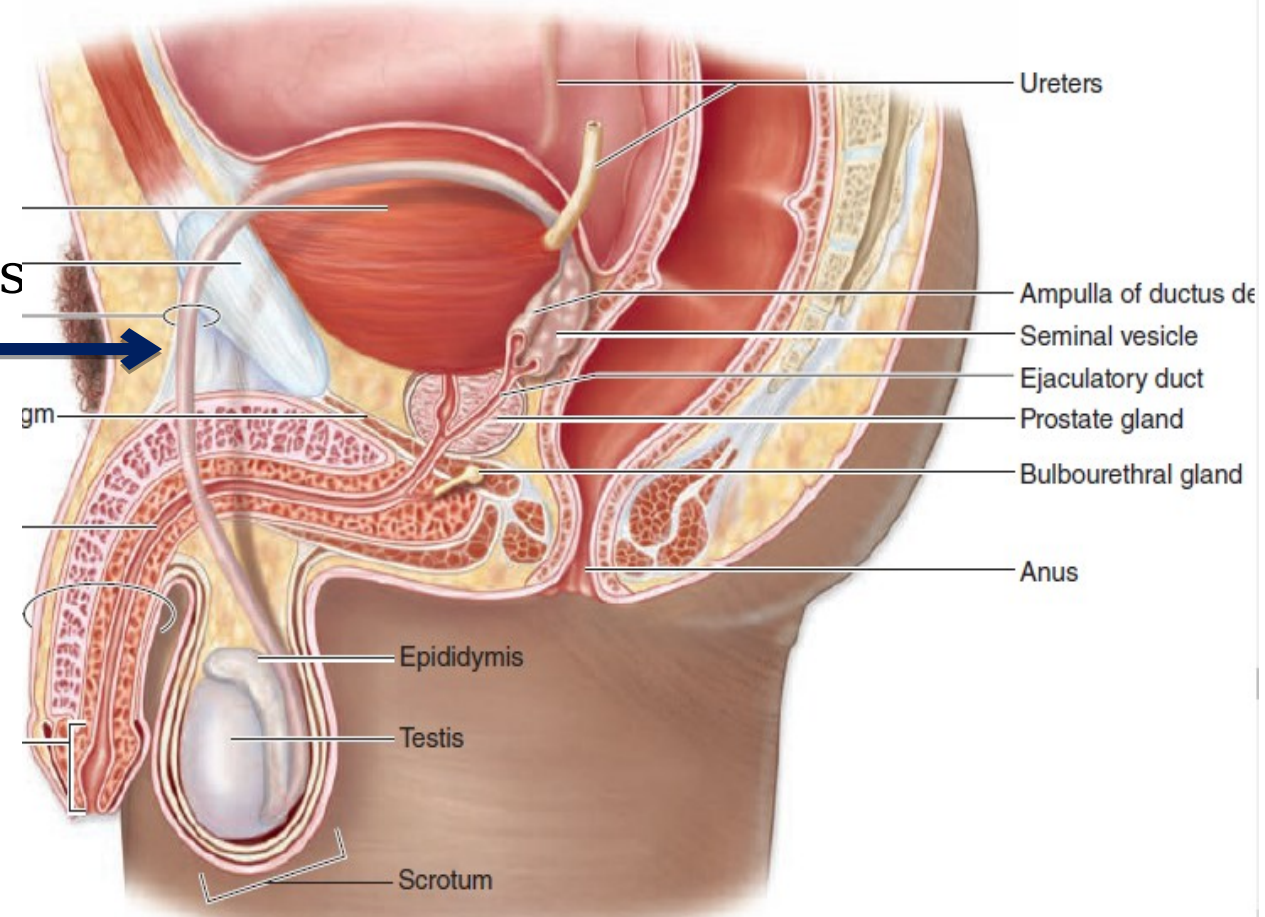
3- **Accessory organs**

1- Prostate

2- Seminal vesicles

3- Bulbourethral gland

4- **Penis**



Testis

Site: **outside** the body in the scrotal sac

Shape: **oval**

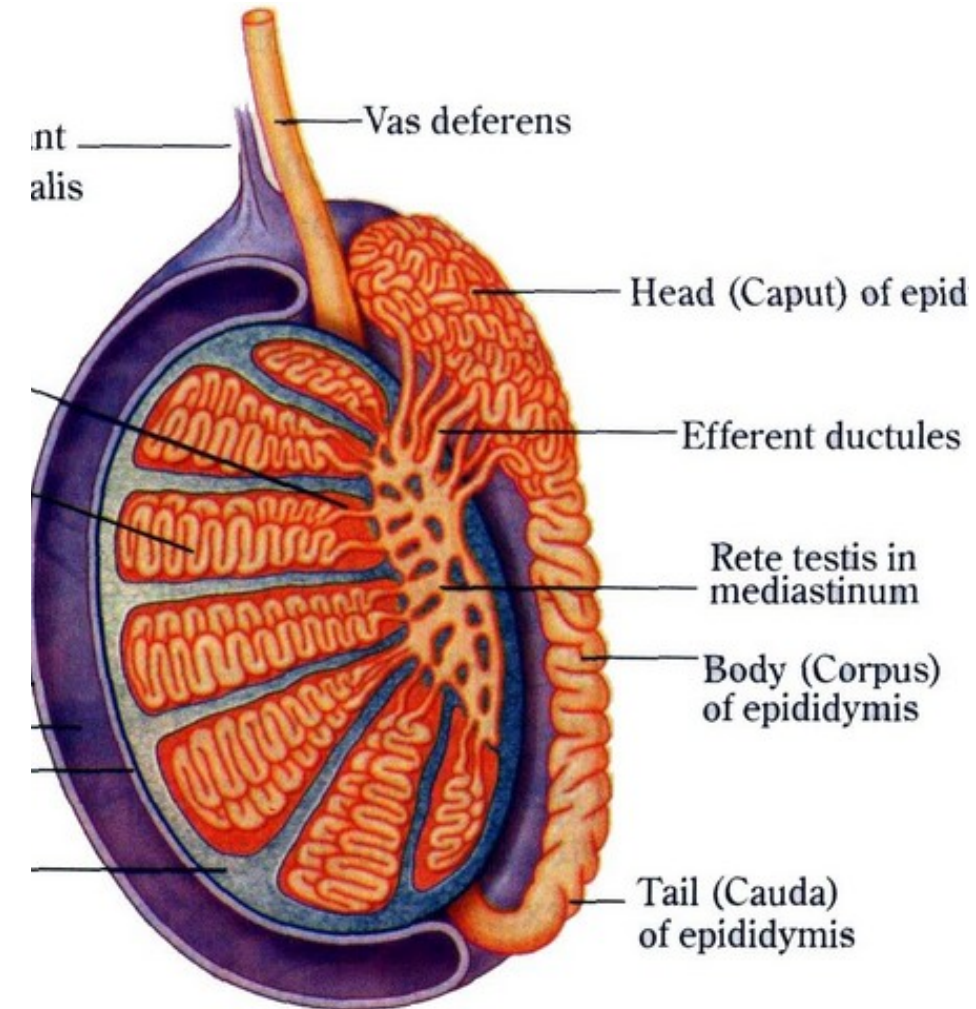
Testis is a **mixed** gland
Endocrine **Exocrine**
Testosterone Sperm

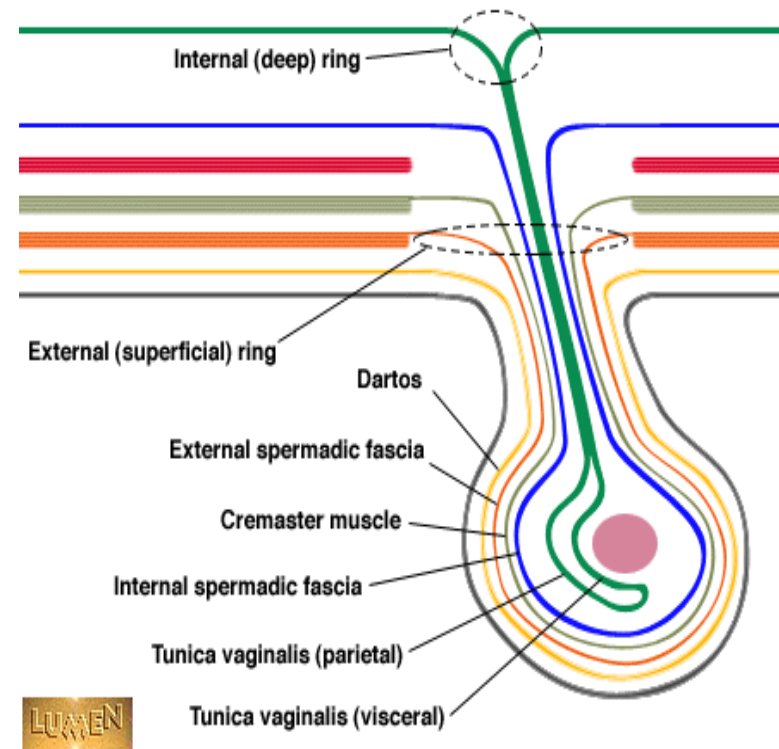
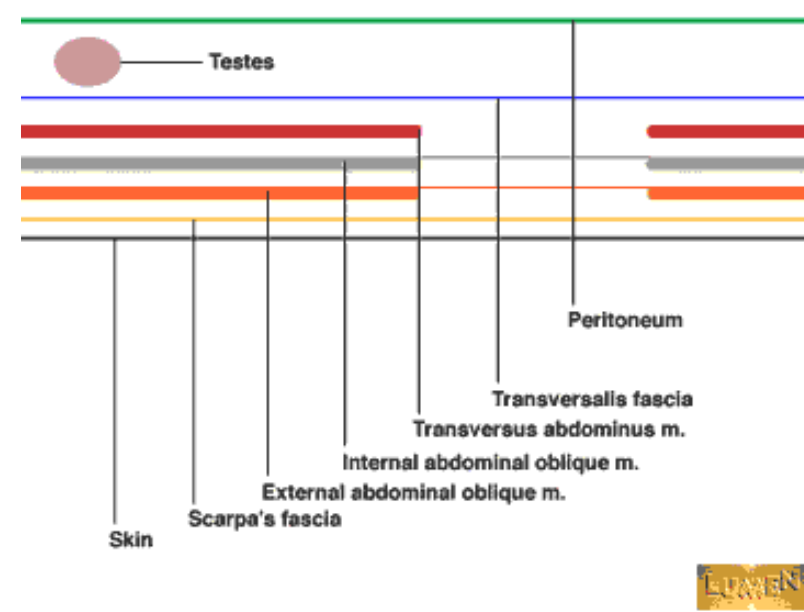
Testis is surrounded by 3 layers

- 1- **Tunica vaginalis**

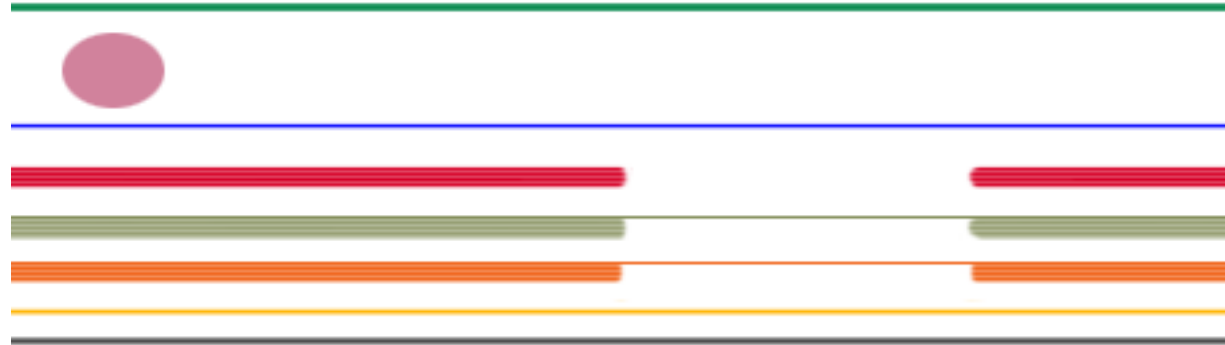
- 2- **Tunica albuginea**

- 3- **Tunica vasculosa**





Testis



Testicular coverings



1- Tunica vaginalis

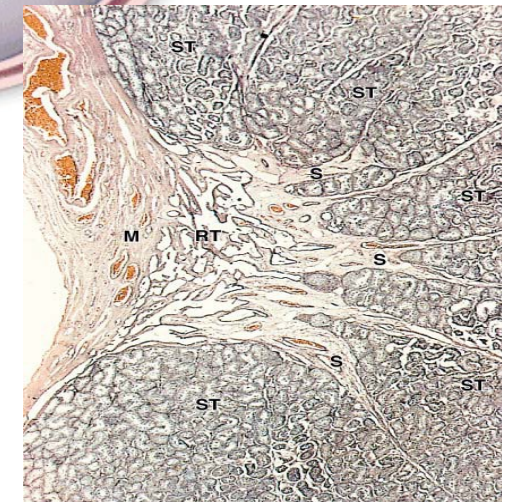
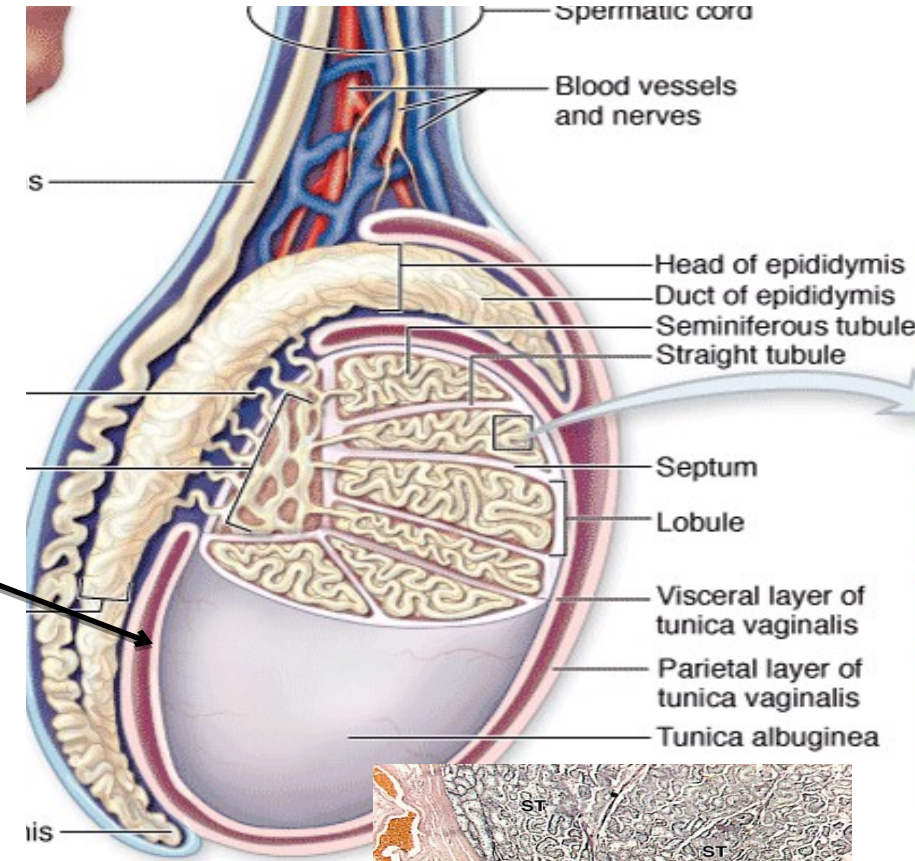
outer parietal layer, **inner visceral** layer of peritoneum serous sac

2- Tunica albuginea

packed **collagen** fibers & elastic fibers.
thickens posteriorly forming **mediastinum testis**
Septa arise divide the testis into about 250 compartments (**lobules**)

3- Tunica vasculosa

loose C.T. rich in blood vessels



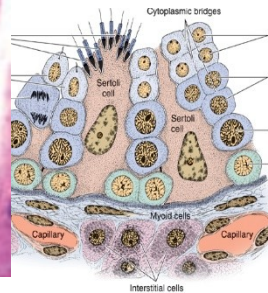
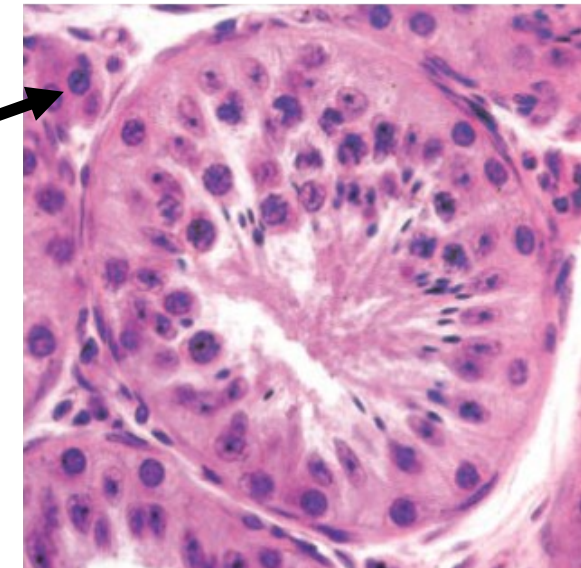
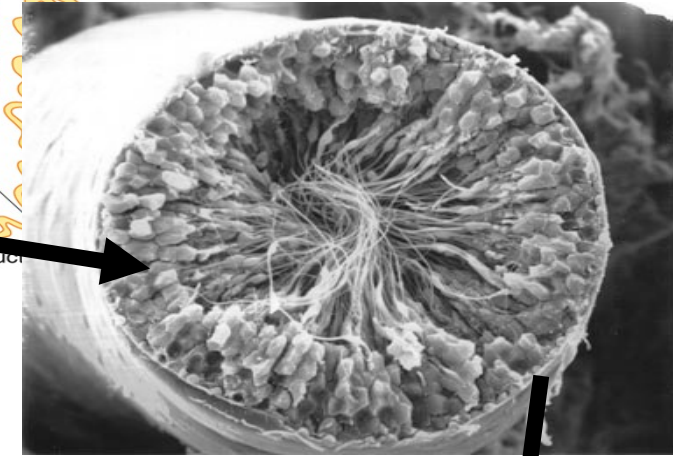
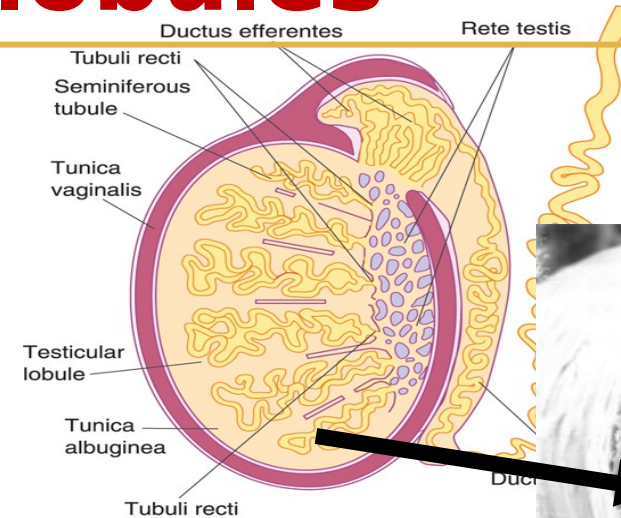
Testicular lobules

250 lobules

Each lobule contains:

a) 1-4 highly convoluted **seminiferous tubules** for sperm production

b) Sparse connective tissue containing endocrine **interstitial cells** (or **Leydig cells**) secrete testosterone



Semineferous tubules



Shape: **highly coiled** so each tubule is cut several times in any section.

Size: 30-70 cm in length, 150-250 μm in diameter. It is **surrounded** by a **basement membrane** that is **surrounded** by spindle shaped **myoid cells**.

Myoid cells are **contractile** helping the spermatozoa & testicular fluid to move.

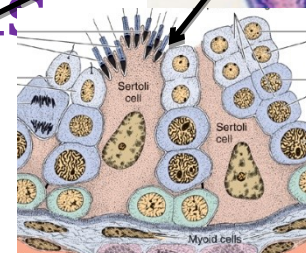
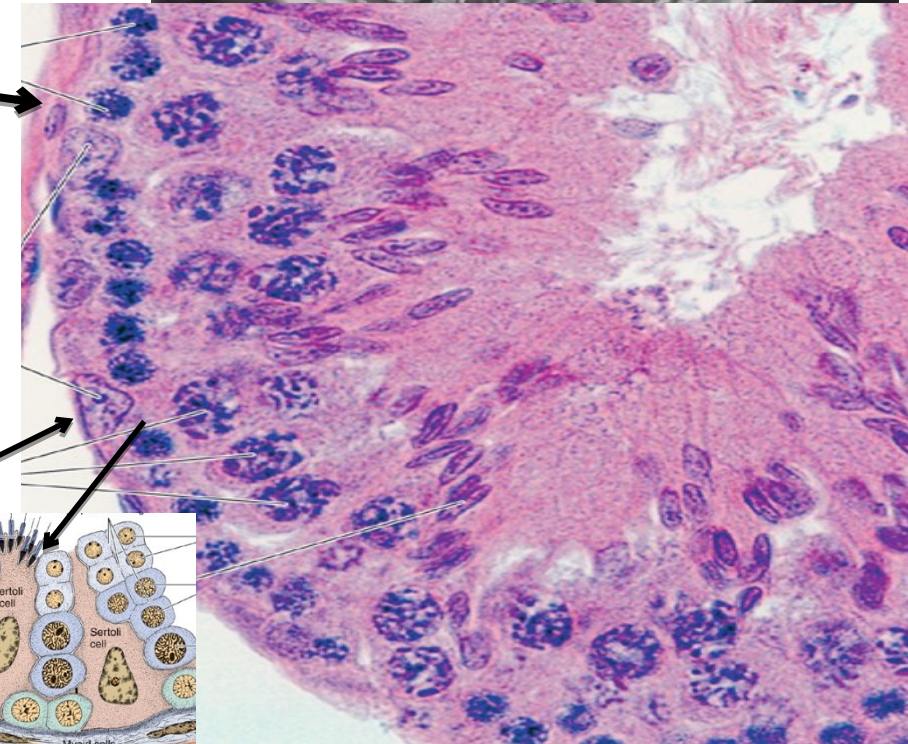
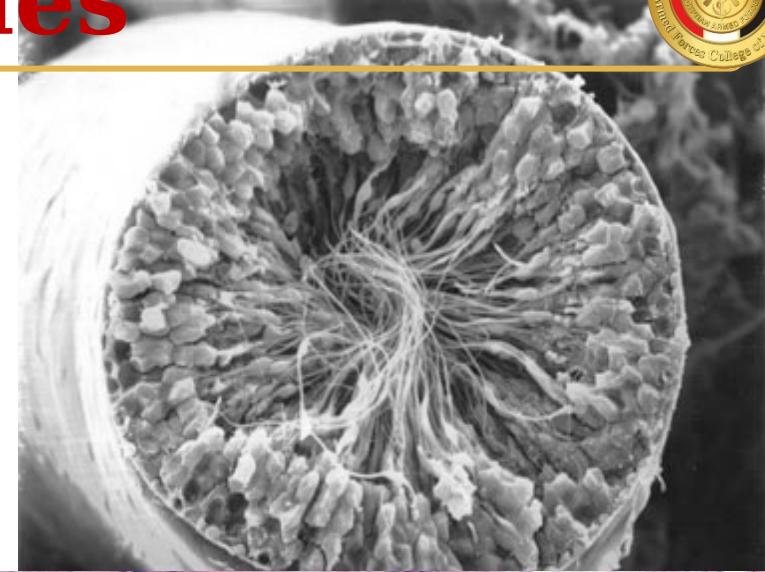
lined by

Spermatogenic cells

Germinal epithelium; various stages of **sperm formation**
Dividing cells

Sertoli cells

supporting
Non-dividing



Sertoli cells



Number: **few**

But

Sertoli cells is the main type of cells until puberty. After puberty, they form 10% of cells lining seminiferous tubules. Sertoli cells do **not** replicate after puberty

LM:

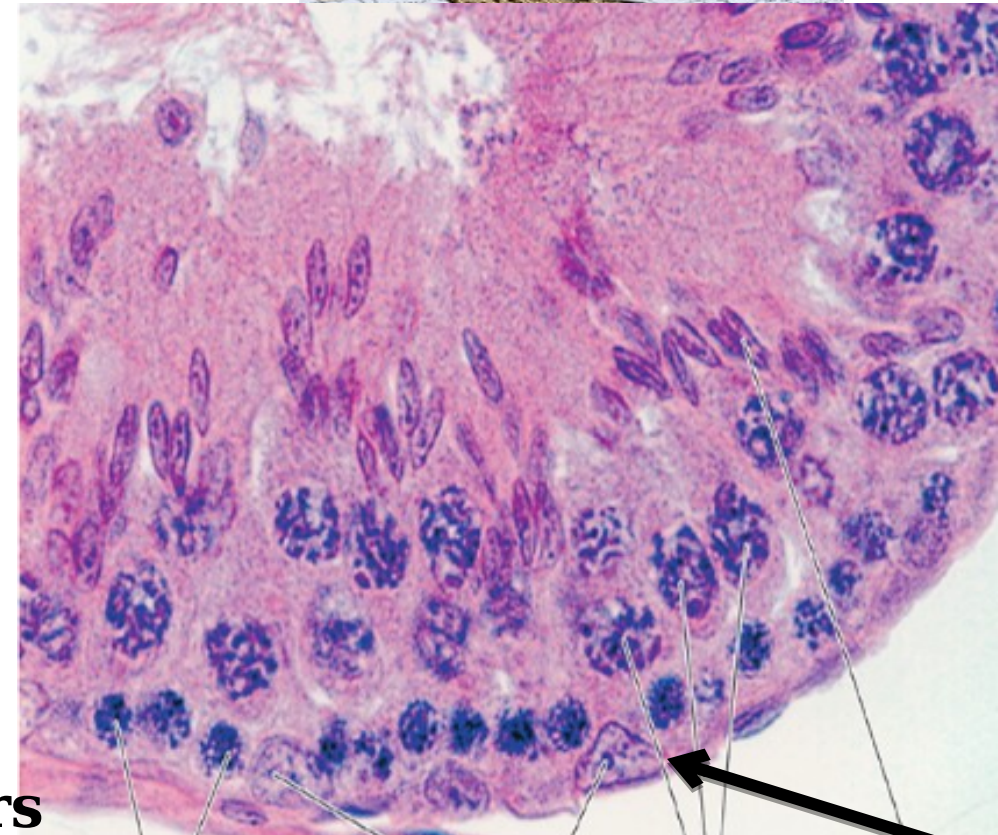
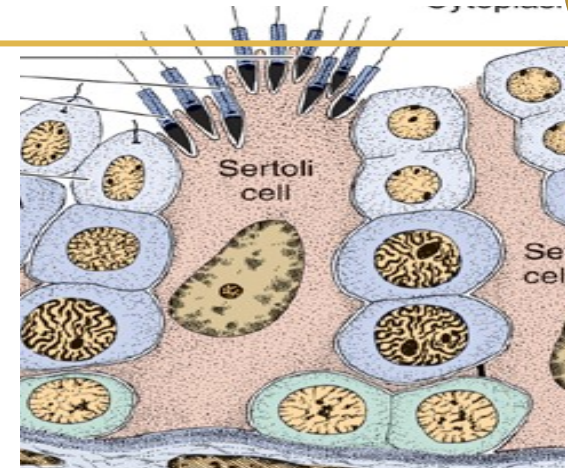
Site: rest on the basement membrane of seminiferous tubules and extend to their lumina.

Shape: **highly columnar** cells with **irregular indistinct** cell boundaries.

Cytoplasm: **pale acidophilic**

Nucleus: **large intended basal oval, vesicular** with prominent nucleoli.

Plasma membrane of Sertoli cells have **receptors for FSH**

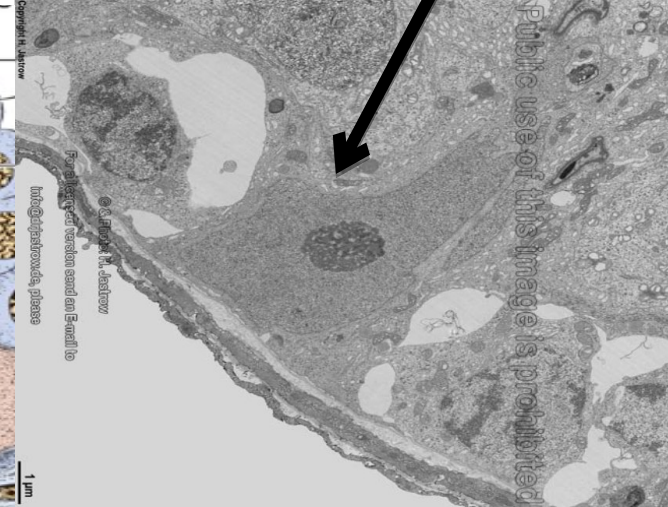
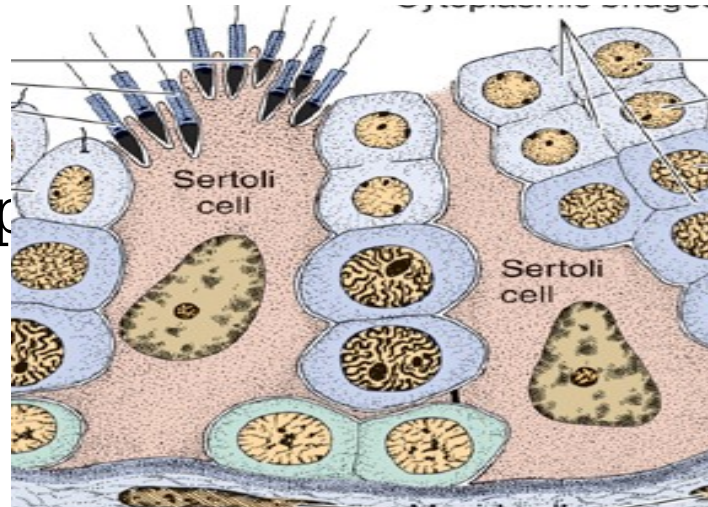


Sertoli cells



EM: Cytoplasm contains:

- abundant **SER**,
- RER**, well-developed Golgi comp
- numerous mitochondria,
- lysosomes**,
- free ribosomes,
- lipid droplets, glycogen granules.

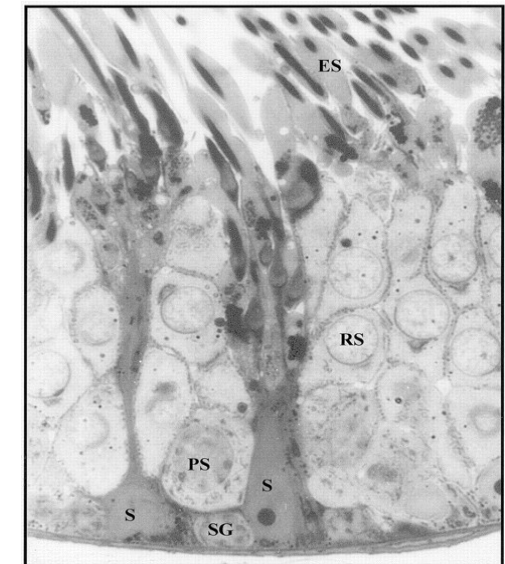


Cell membrane shows **pockets** where the developing spermatogenic cells are present.

Abundant **cytoskeleton** of a meshwork of

- **Actin** filaments,
- **Intermediate** filaments,
- **Microtubules**.

For **changing the shape** of Sertoli cells which helps in **movements of germ cells towards the surface**.



Sertoli cells



Lateral surfaces of adjacent Sertoli cells form **tight junctions**

forming **blood-testis barrier**

dividing the seminiferous tubules into

a- **basal compartment** and

b- **adluminal compartment**

1) **Basal compartment**: - narrow,
contains

spermatogonia.

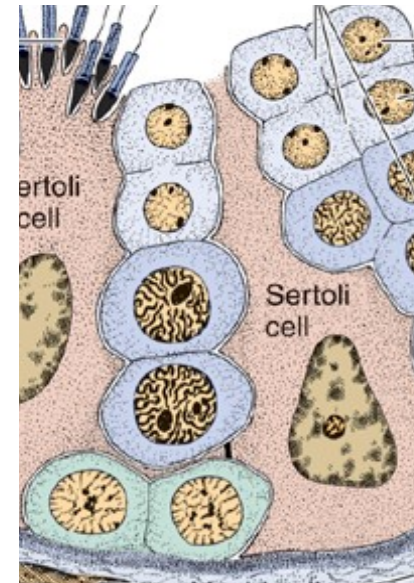
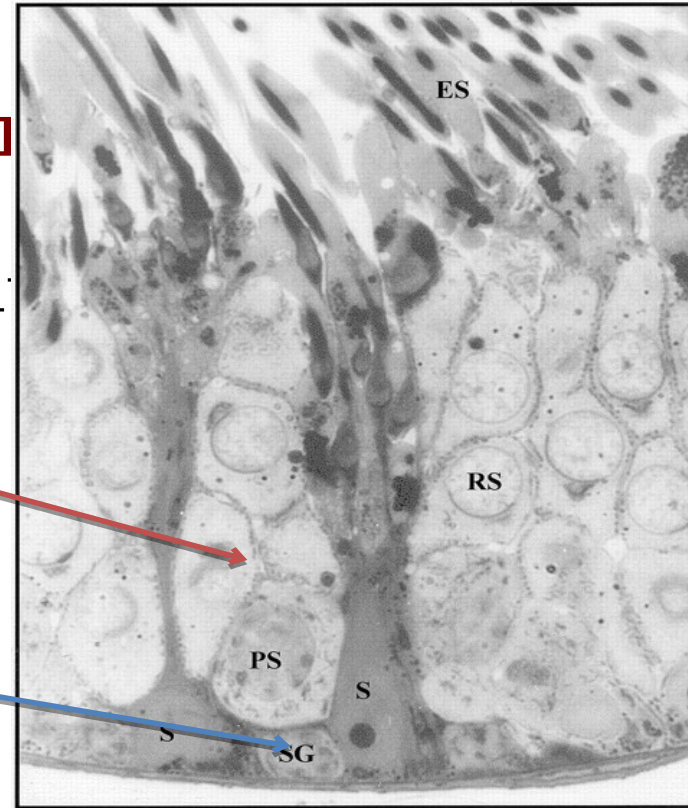
2) **Adluminal compartment** : - wider,
- above the zonula occludens

- contains primary spermatocytes, secondary spermatocytes,

spermatids, spermatozoa

1) **protects** the developing gametes from the **immune system**; it prevents the antigenic properties of sperm from passing to the blood and stimulating an immune response.

2) **protects** the developing spermatocytes from **drugs and toxic** chemicals found in the blood,



Sertoli cell Functions



I- Nutritional: fluid: **fructose-rich**. nutrition to the spermatogenic cells

II- Exocrine and endocrine functions

1-Secrete **Androgen binding protein** under effect of FSH. It increase concentration of testosterone in testicular fluid which is necessary for spermatogenesis.

2- Secrete **Transferrin** to transport iron to maturing gametes, Ceruloplasmin; copper transport

3- Secrete **Inhibin** hormone which inhibits release of FSH

III- Phagocytose cytoplasmic remnants of spermatids.

IV- Support and protection of developing sperms

1-Support and control movement of spermatogenic cells present inside surface pockets of Sertoli cells.

2- Form **blood testis barrier**

Give reasons:

- Sertoli cells have lateral pockets
- Sertoli cells are rich in lysosomes
- Sertoli cells are rich in RER
- Sertoli cells are rich in SER

Compare between basal and adluminal compartments of seminiferous tubules:
Types of cells:.....

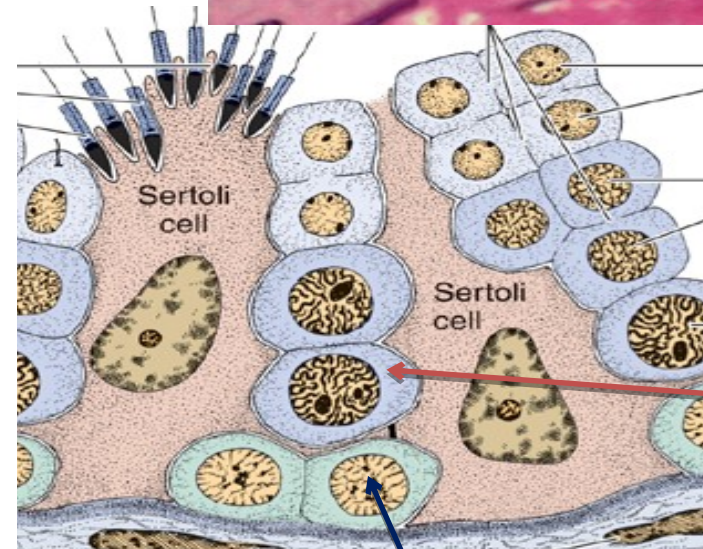
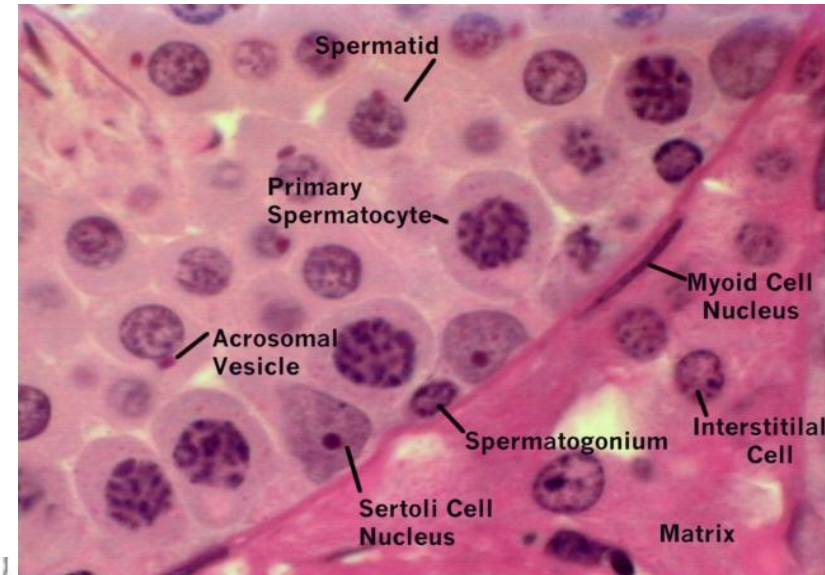
Spermatogenic cells



4-8 layers line the seminiferous tubules

Spermatogenic cells include:

- 1- **Spermatogonia**
- 2- **Primary spermatocytes**
- 3- Secondary spermatocytes
- 4- Spermatids
- 5- Spermatozoa



Primary spermatocytes

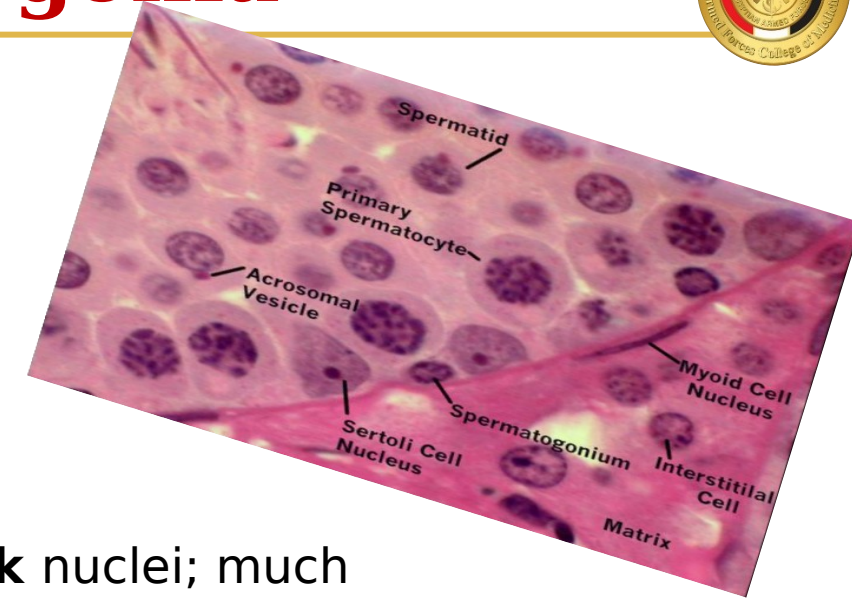
Spermatogonia

Spermatogenic cells; Spermatogonia



Site: **basal** compartment of seminiferous tubules
 Small rounded or oval **stem cells** **44 s-chromosomes** (44+XY)

Types of spermatogonia: (type A & type B)



Dark type A spermatogonia

(**dark** nuclei; much heterochromatin)

dark type A spermatogonia

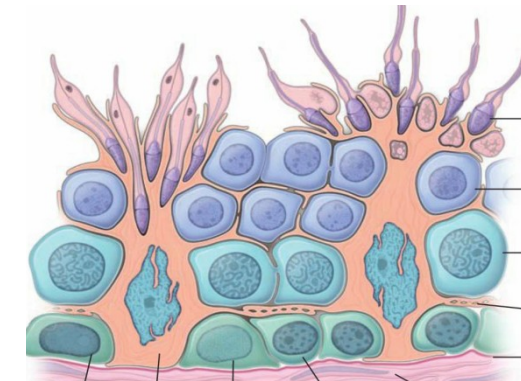
pale type A spermatogonia

(**Transit amplifying progenitor cells**)

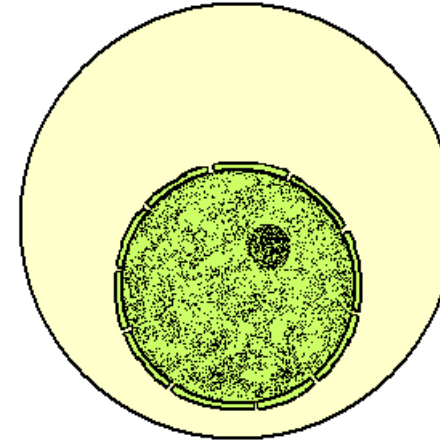
Spherical
 with pale
 nuclei

Type B spermatogonia

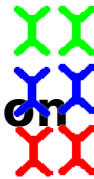
Primary spermatocytes



Primary spermatocytes (46 d-chromosomes)



first meiotic division



Secondary spermatocytes

23 d-chromosomes

Secondary spermatocytes

23 d-chromosomes

Second meiotic division



Spermatozoa

23 s-chromosomes 23 s-chromosomes 23 s-chromosomes 23 s-chromosomes

Spermatogenic cells; **Primary spermatocytes:**



Site: **Adluminal** compartment.

Size: **Largest** cell; **16 μm** in diameter.

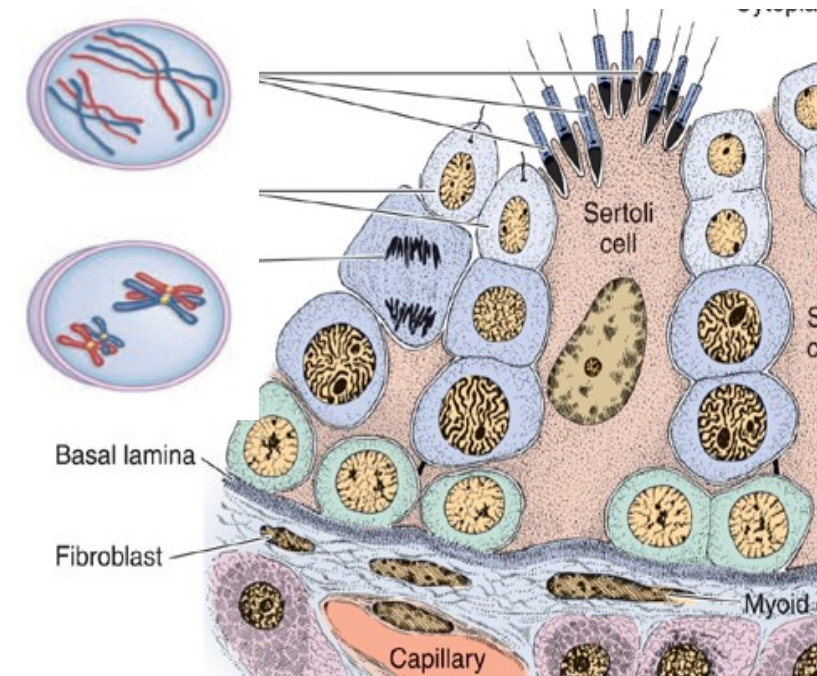
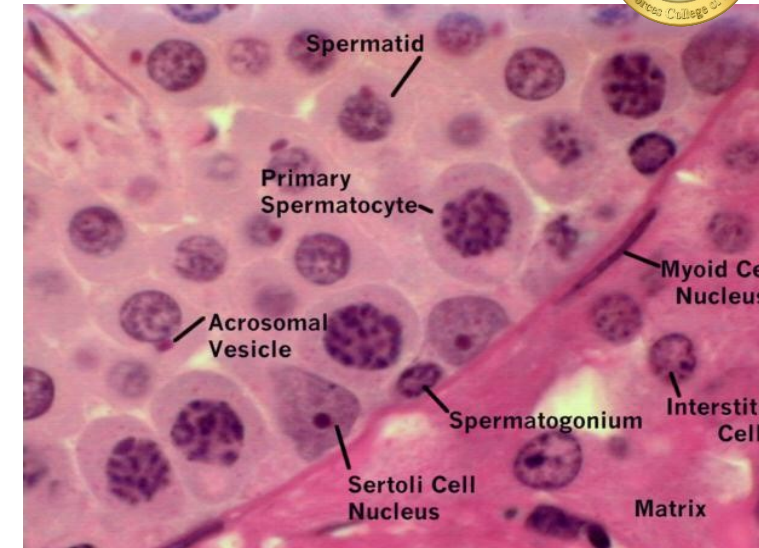
LM: partially condensed chromosomes in various stages of synapsis and recombination

After their formation, primary spermatocytes enter the **S phase** of the interphase of the cell cycle,

duplicate their DNA

nucleus contains **46 d-chromosomes (4n)**
(46 (44 + XY) chromosomes, diploid number, DNA content of 4N)

-Primary spermatocytes undergo the **first meiotic division** with **prolonged prophase (22 days)** **showing synapsis & recombination** giving rise to 2 secondary spermatocytes.
so a section in the testes shows many primary spermatocytes.



II- Secondary spermatocytes

Size: **smaller** than primary spermatocytes.

Shape: **rounded** cells

Chromosomes: **haploid** number of chromosomes (**23 d**-chromosomes)

They **soon** enter the **2nd meiotic division** giving 2 spermatids.

So they are **hardly seen** in a section of testes.

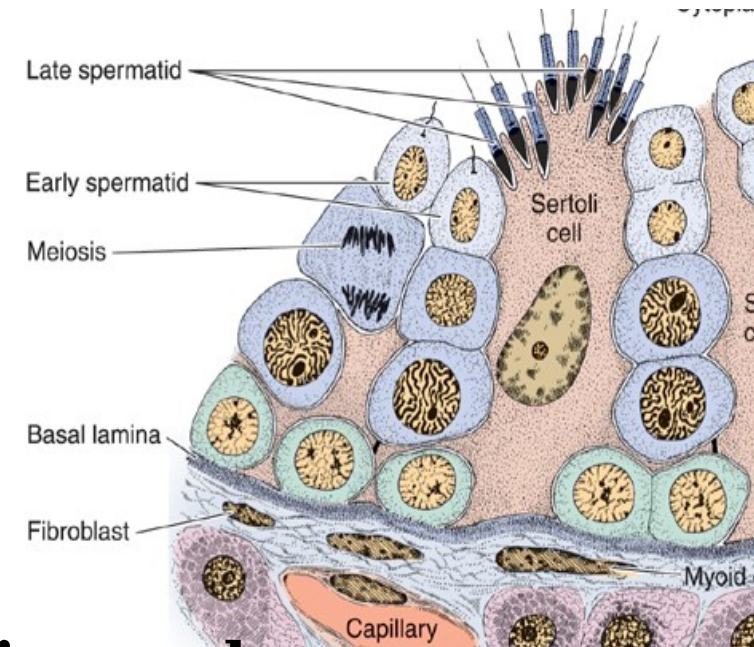
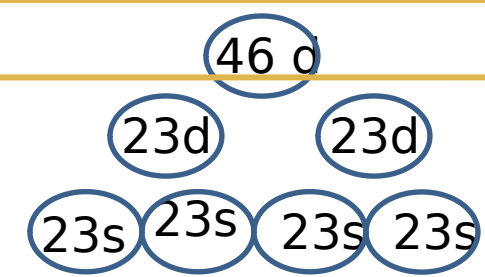
Small, rounded, near the lumen of seminiferous tubules

Chromosomes: **23 s**-chromosomes (haploid number)

Spermatids have -abundant RER, well-developed **Golgi complex**, numerous **mitochondria**

-Spermatids do **not** divide but change by **spermiogenesis** into spermatozoa.

In subsequent divisions, cells remain attached by **intercellular bridges** ~~spermatogenic syncytium~~



Spermatozoa



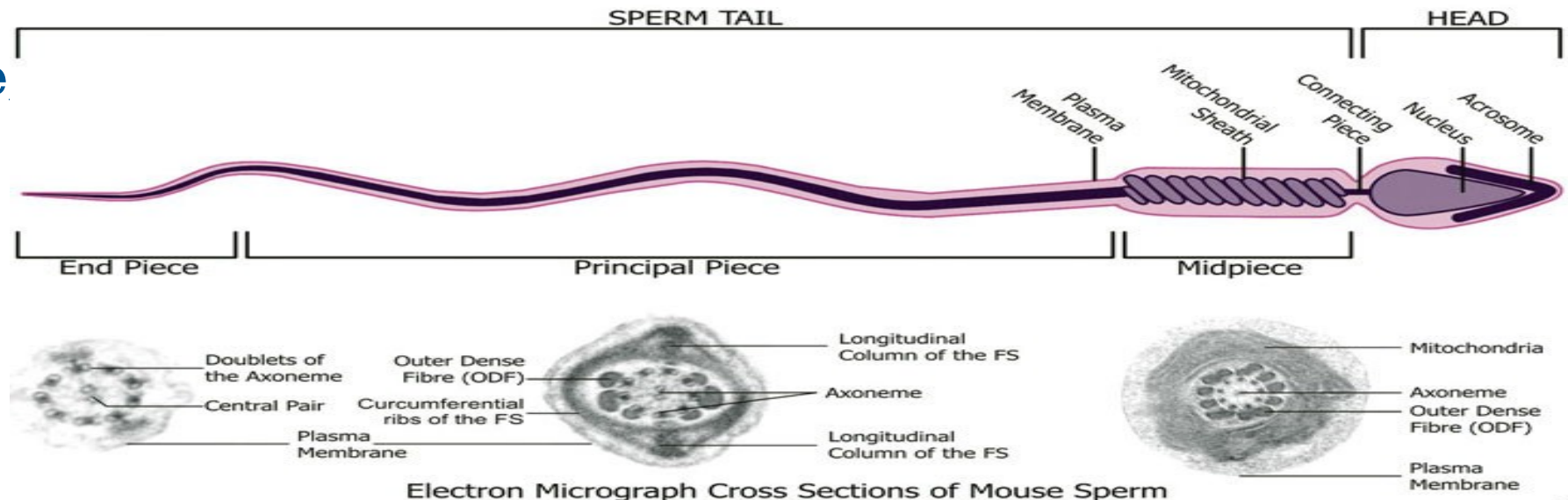
Sperms arise from spermatids by spermiogenesis

formed of **head** & **tail** which is divided into:

- **neck,**
- **middle piece,**
- **principal piece**
- **end piece**



nucleus



Spermatozoa

- Head:**
- a- **pyriform** in shape, **5 μm** in length
 - b- **Flattened**
 - c- Pyriform nucleus with **condensed chromatin**
 - d- The nucleus is covered at its 2/3 by a cap called **acrosomal cap**.

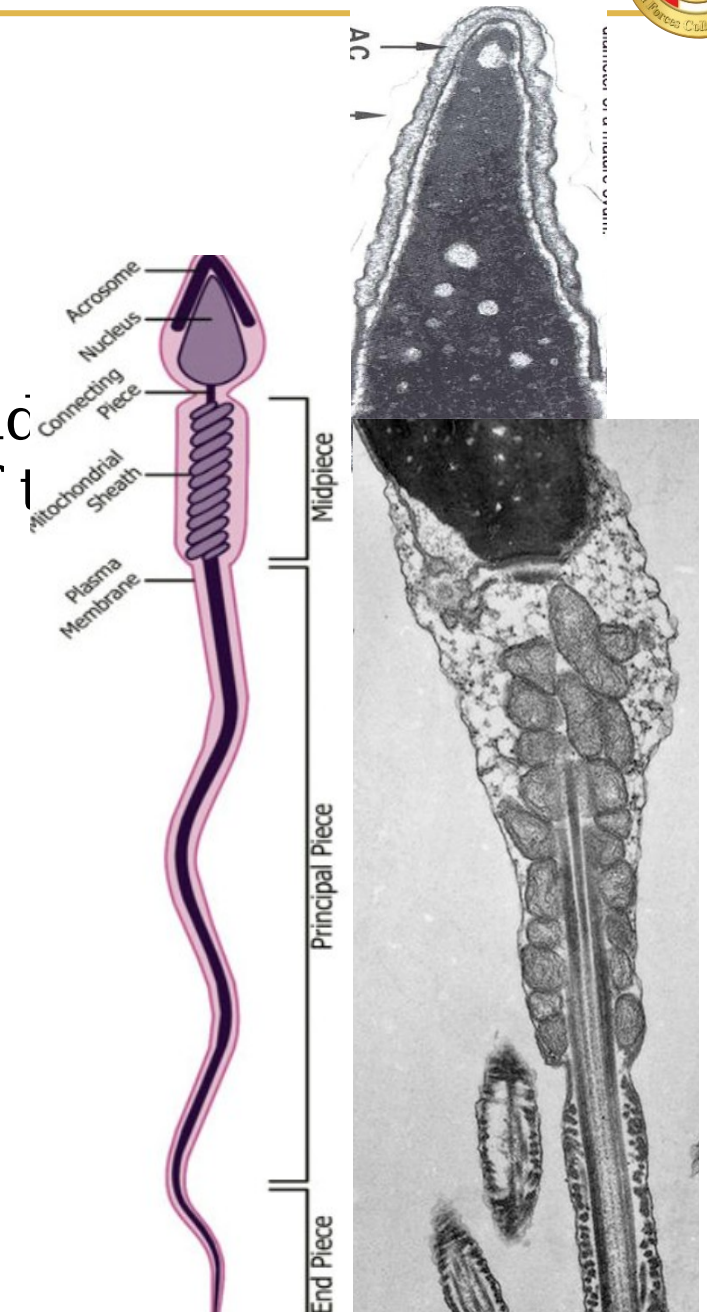
Acrosome containing numerous enzymes (proteases, acidic phosphatase, hyaluronidase) which helps penetration of

ovum.
Sperms are attached by their heads to the **apex** of **Sertoli** cells

Neck of sperm (connecting piece):

- a- **narrow** part connecting the head to middle piece.
- b- contains **centriole**.
- c- contains the connecting piece formed of **9 fibrous rings**

An axoneme begins behind the centriole and passes



Spermatozoa



Middle piece of sperm is:

5 μm in length

contains axoneme formed of

2 central singlets & 9 peripheral doublet microtubules

surrounded by **9 fibrous rings** &

spiral sheath of mitochondria

Principal piece of sperm:

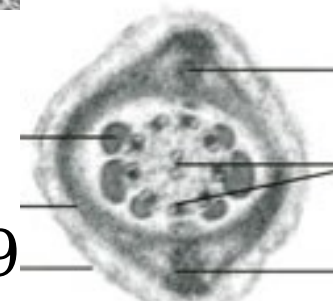
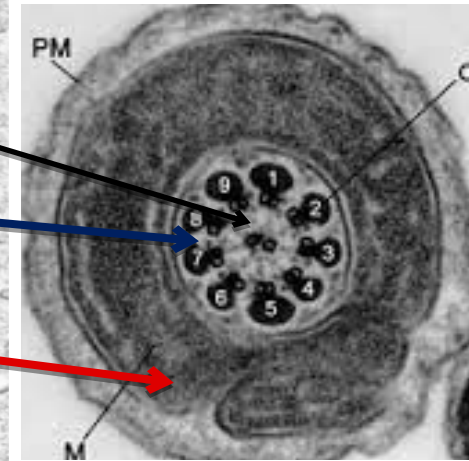
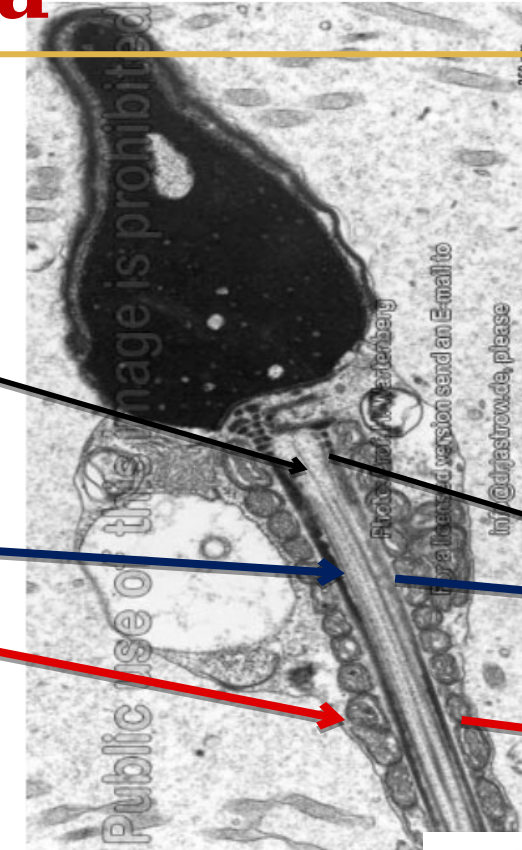
a- **longest**, 50 μm length

b- formed of 2 central singlets and 9 peripheral doublets microtubules surrounded by **circumferential fibrous sheath**

covered by the plasma membrane

End piece formed of 2 central singlet microtubules & 9 peripheral doublets covered by plasma membrane

In the last 0.5 μm , the 20 microtubules are haphazardly arranged



Spermiogenesis



Process by which spermatid is transformed into spermatozoon

Temperature sensitive
includes 4 phases: 1- Golgi phase,
2- Cap phase,
3- Acrosomal phase,
4- Maturation phase

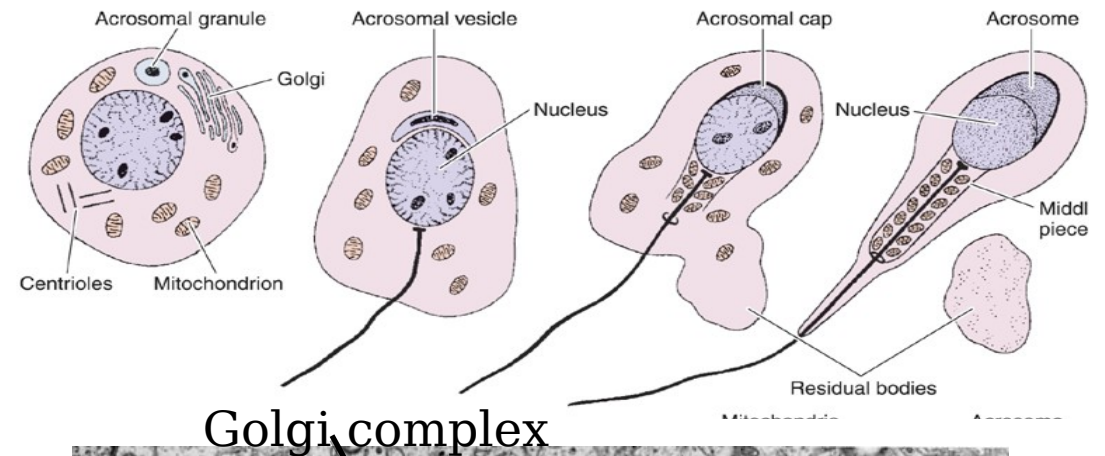
1- Golgi phase:

Small **proacrosomal** vesicles from the Golgi complex

fuse together forming a **single acrosomal vesicle**.

Acrosomal vesicle binds with the nuclear envelope at the **anterior pole**.

Centrioles migrate back to posterior pole of the cell to give the flagella



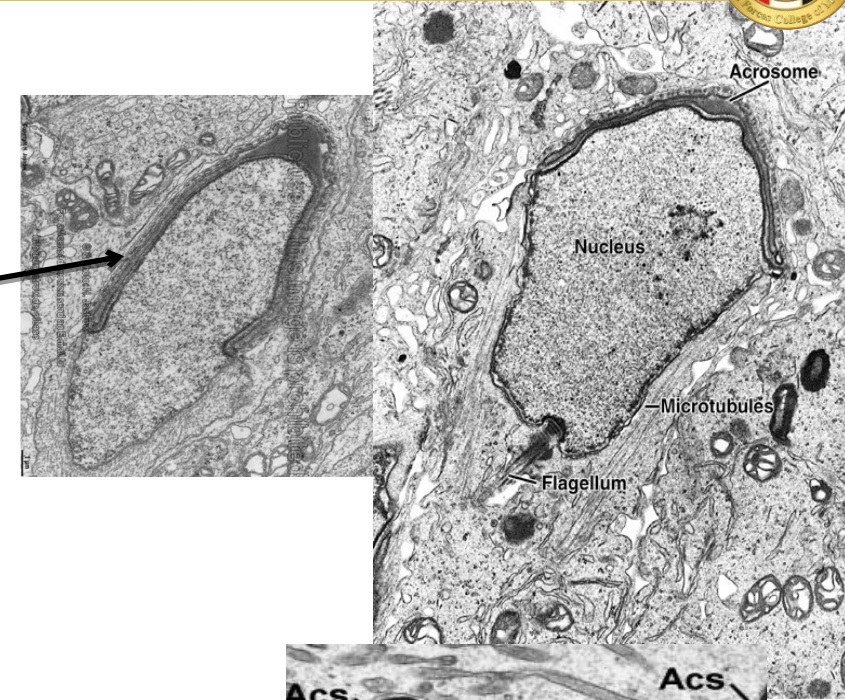
Acrosome formation

Spermiogenesis



2- **Cap phase** :

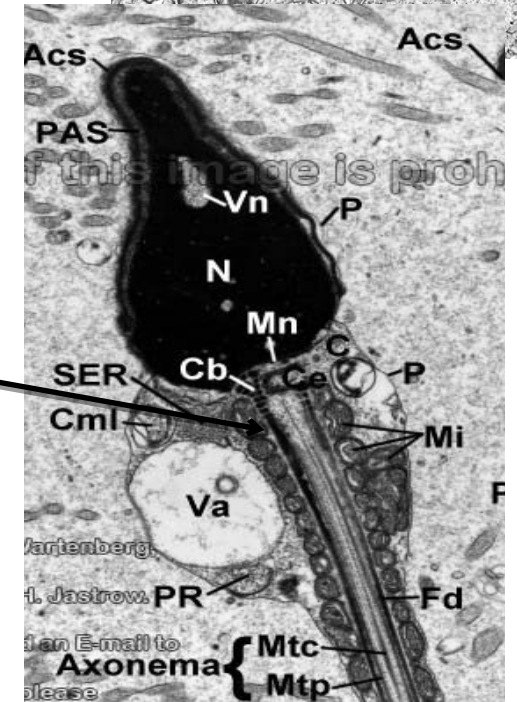
- **Acrosomal vesicle** enlarge & surrounds the anterior 2/3 of the nucleus & is known as **acrosome** (or acrosomal cap) Contain hyaluronidase and protease called **acrosin**.
- **Distal** centriole starts forming the flagellar



3- **Acrosomal phase** :

-cell elongates, centriole forms the neck

- **Axoneme** (9doublets + 2singlet microtubules) extends into the tail.
- **9 coarse fibers** develop in the neck region around the axoneme.
- **Mitochondria** become arranged **helically** in the middle piece around the 9 coarse fibers (**mitochondrial sheath**).



Surplus cytoplasm migrates to posterior part of the cell

Spermiogenesis



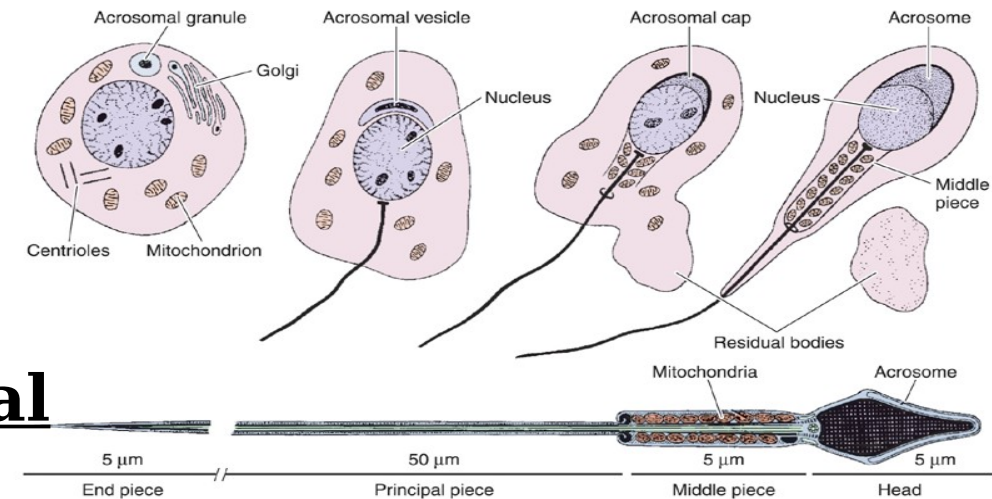
4- **Maturation phase :**

- unneeded cytoplasm is shed as a **residual body**
- Remaining intercellular bridges are lost
- Sperms (fully formed but not functionally mobile) are released into the lumen (**spermiation**) .
- The cellular remnants are **phagocytosed** by **Sertoli** cells.

Formed spermatozoa are **immotile** & **gain motility while passing through the epididymis**.

NB. Significance of the acrosomal cap:

Enzymes as protease and hyaluronidase E. They are released when the sperm contact an ovum to facilitate penetration of corona radiata and zona



Lecture Quiz



A 26-year-old man presents to the clinic with his wife complaining of primary infertility. His testosterone level is normal. Semen analysis shows no detectable sperm. Testicular fine-needle biopsy demonstrates no detected spermatozoa in the lumen of the seminiferous tubules. The doctor told him that he has a problem in the spermiation with failure of spermatids to separate from which of the following cells?

- A. Spermatogonia
- B. Sertoli cells
- C. Primary spermatocytes
- D. Myoid cells
- E. Interstitial cells of Leydig

SUGGESTED TEXTBOOKS



- 1. Junqueira`s Basic Histology; Text and Atlas. 15th edition 2018.**
- 2. Histology A Text and Atlas: Michael H. Ross and Wojciech Pawlina, 7th edition, 2016.**



Thank
you

